ANTHELMINTIC EXPERIMENTS WITH HOGS

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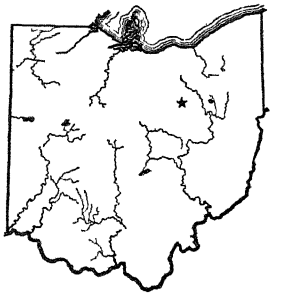

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BULLETIN
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ANTHELMINTIC EXPERIMENTS WITH HOGS

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In its flocks and herds the Ohio Experiment Station has several hundred head each of sheep, hogs, and cattle. These animals are used mainly for experimental studies of feeding and management. Nevertheless, where such large numbers of animals are reared, opportunities frequently arise for the testing of anthelmintics. The animals used in the tests here reported were hogs only, altho, in a few instances, similar tests were made with sheep and horses.

The anthelmintics were directed mostly toward *Ascaris suum*, but when the opportunity presented itself, observations were also made upon the efficacy of the anthelmintic toward other parasites of the alimentary tract.

Ascaris suum is a common parasite of the small intestine of the hog. Until recently the damage accredited to this worm has been limited to digestive disorders, for the adult worms live unattached in the small intestine. Recent investigations, however, indicate that the larval forms may develop in various organs and tissues outside of the digestive tract, thus acting as foreign bodies and occasioning varying degrees of injury according to their location. Further investigation will probably show this worm to be the cause of some of the numerous troubles and diseases that attack the young pig during the most critical period of its existence—namely, while it is attaining the weight of 50 to 60 pounds.

The practice of the oral administration of drugs and chemicals for the purpose of removing worms from the alimentary tract is an old one that has been employed with varied success by the Medical and Veterinary professions. The noted French authority, Railliet (1915), states that it is difficult to expel parasites from the large intestine by oral medication in any host species. Stiles and Pfender

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(1902) have found that thymol, the classic remedy for hookworms in man, was without effect on whipworms of the caecum of the dog. On the other hand, Miller (1904) claims to have succeeded in removing whipworms from the dog by the use of oleoresin of male fern. Hall, Wilson, and Wigdor (1918) report unexpected success in the removal of strongyles from the large intestine of the horse by the use of oil of chenopodium. Stiles (1901) has reported satisfactory results from the use of a one percent solution of coal-tar creosote in water for the stomach worms of sheep. Powers (1909) on the other hand considers medicinal treatment for stomach worms in ruminants (cattle and sheep) very unsatisfactory. For hookworms and other intestinal parasites of ruminants, Ransom (1915) states that no uniformly satisfactory medicinal treatment by way of the mouth is yet available. Even in those animals with simple stomachs and relatively short alimentary tracts the use of the commonly recommended anthelmintics may not always prove effective, as is shown by the results obtained by Hall and Foster (1918) and by those reported in this bulletin.

This subject heretofore has been approached mainly from the clinical point of view. In some instances the efficacy of the treatment has been checked by fecal examinations for eggs persisting in the feces or for worms passed, or by a post-mortem examination. While these methods may give valuable information, they lack completeness. A more dependable method of determining anthelmintic efficacy would include the following steps:

1. Determine infestation by an examination of the feces for eggs.
2. Administer the anthelmintic.
3. Recover all worms that may be present in the feces for several days after treatment and identify the worms.
4. Finally kill the animal and collect and identify all worms remaining.

The ratio existing between the worms passed and those remaining alive and in their normal location in the alimentary tract will give a fair measure of the anthelmintic efficacy of the drug. This method was used by Hall (1917) in connection with a study of the effectiveness of carbon bisulphide on bots of horses.

While it is thus possible to express the efficacy of a drug in the form of mathematical ratio, such a ratio, as Hall has pointed out, except when based upon extensive data, cannot be considered an accurate index of the efficacy of the drug. Too many factors not entirely within the control of the operator, such as the individual reaction of the animal, amount of material in the alimentary tract, the potency of the drug, and the "drug resistance" of the parasite, may enter into the problem.

In the experiments at the Ohio Station some of the anthelmintics that are commonly recommended for removing worms from the alimentary tract of sheep and hogs were tested. These anthelmintics were Santonin; Santonin and Calomel; Santonin, Areca Nut, Calomel, and Soda; Santonin, Calomel, and Soda; Calomel and Aloes; Copper Sulphate; Arsenic; Turpentine; Iron Sulphate; Pumpkin Seeds; and Oil of Chenopodium. With the exception of copper sulphate and oil of chenopodium, the drug was administered with the feed. The oil of chenopodium, mixed with castor oil and, in one test, a copper sulphate solution, was administered by means of a drenching bottle. The administration of the drug was usually preceded by a dose of salts and a fast, followed by a dose of salts.

SANTONIN

Santonin is a classic remedy for ascarids and is commonly prescribed as a remedy for worms in children. It has been widely used, also, as a worm remedy for dogs and was much recommended for round worms (*Ascaris suum*) in swine. However, the present price of the drug almost prohibits its use in veterinary practice.

Santonin, which is largely of Asiatic or European origin, is sold in ounce containers by druggists in this country. The fine crystaline or powder form lends itself readily to administration with the feed, thus avoiding the time, labor, and danger of individual dosage. If the medicine is thoroly mixed with the feed, and the lot to be dosed is small and the pigs of about the same size, it is assumed that each animal will get its share of the medicine. From 3 to 5 grains (.1944 to .324 gram) of santonin per 100 pounds live weight is the usual recommendation.

The tests of santonin at the Ohio Station were as follows:

TEST OF TEN GRAINS SANTONIN GIVEN IN TWO DOSES

I. On January 16 and 17, 1913, eight lots of experimental pigs were treated as follows:

January 16, a. m.	1 heaping teaspoonful Epsom salts per pig administered in ½ regular feed.
p. m.	5 grains (324 mgm.) santonin per pig administered in ½ regular feed.
January 17, a. m.	5 grains santonin per pig administered in ½ regular feed.
p. m.	1 heaping teaspoonful Epsom salts per pig administered in ½ regular feed.

Results of this treatment are presented in Table I.

TABLE I.—TEST OF TEN GRAINS SANTONIN GIVEN IN TWO DOSES

Lot	No. of pigs	Gain during week of treatment pounds	No. of worms				Total
			January 17		January 18		
			A. M.	P. M.	A. M.	P. M.	
1	4	18.5			6	2	8
2	4	15.5	2		3	4	9
3	4	23.5	2		3	1	6
4	4	21.5			5	1	6
5	4	28.5					0
6	4	22.0			2		2
7	4	23.5		1	13	2	16
8	4	16.0			4		4
Total..	32						51

TEST OF REPEATED ADMINISTRATION OF SANTONIN

II. On April 15, 1913 pigs number 88 and 20 were placed in separate pens. A microscopical examination of their feces showed both pigs to be infested with ascarids. On April 29 and 30 they were treated individually as follows:

April 29 1 heaping teaspoonful Epsom salts in evening feed.
April 30 5 grains (324 mgm.) of santonin in morning feed.

No worms were found in pens after treatment, and on May 8 a fecal examination showed 241 ascarid eggs on one slide from pig No. 88 and 38 on one slide from No. 20. They were again treated as follows:

May 14, p. m. No feed.
May 15, a. m. Dose of Epsom salts in feed.
p. m. 5 grains santonin in feed.
May 16, a. m. Dose of Epsom salts in feed.

No worms were found in the pens after treatment, and on May 20 a microscopical examination of the feces revealed 43 ascarid eggs on one slide for No. 88 and 279 for No. 20. They received a third treatment:

June 9, p. m. No feed.

June 10, a. m. Mixed with ½ regular feed { santonin, 5 grains (324 mgm.); sodium bicarbonate, 30 grains, (2 gm.); areca nut, 1¼ drams, (5 gm.); calomel, 2 grains (129.6 mgm.

No worms were found in pens, and June 12 feces from pig No. 88 showed 110 ascarid eggs on one slide, while that from No. 20 showed 173. They received a fourth treatment:

June 16, p. m. Dose Epsom salts in ½ regular feed.
June 17, a. m. 5 grains (324 mgm.) santonin in ½ regular feed.
p. m. 5 grains (324 mgm.) santonin in ½ regular feed.
June 18, a. m. Dose salts in ½ regular feed.

No worms were found in pens, and on June 24 a microscopical examination of the feces revealed for pig No. 88, 285 ascarid eggs and for No. 20, 212. They received a fifth treatment:

July 2, p. m. No feed.
July 3, a. m. In ½ regular feed { santonin, 6 grains (408.8 mgm.) calomel, 6 grains (408.8 mgm.)

No worms were found in pens, and on July 7 a fecal examination was made showing for pig No. 88, 438 ascarid eggs on one slide and for No. 20, 211.

On September 15, a post-slaughter examination of these pigs showed 13 ascarids in the intestine of No. 88 and 34 in the intestine of No. 20. For some unknown reason santonin was without effect in this test. Since some swine have the habit of devouring ascarids, pig No. 88 may have passed worms, which were afterward eaten. However, all the worms passed by pig No. 20 would have been recovered, as it was kept in a narrow shipping crate.

III. Three pigs, which by fecal examination had previously been determined to be infested with ascarids, were treated as follows:

October 13, p. m. No feed.
October 14, a. m. 2 teaspoonful Epsom salts per pig in ½ regular feed.
p. m. 5 grains (324 mgm.) santonin per pig in ½ regular feed.
October 15, a. m. 5 grains (324 mgm.) santonin per pig in ½ regular feed.
p. m. Dose of salts repeated.

October 16 (p. m.) 10 ascarids were found in the pen containing these pigs. On October 17 (p. m.) 8 ascarids were found in pen. On October 21, a microscopical examination of the feces gave the folowing results per slide:

Pig No. 50	29 ascarid eggs and 10 whipworm eggs
Pig No. 81	300 ascarid eggs.
Pig No. 71	19 ascarid eggs.

On October 27, 28, and 29, the treatment of the 13th, 14th, and 15th was repeated. October 30, no worms were found in pen, and on October 31 only 2 ascarids were found. Santonin as administered in this test was only partially effective.

IV. Twelve experimental hogs, each being fed individually, were the subjects of this experiment. The average weight of these hogs was 240 pounds. Each was treated as follows:

May 2, 1917, p. m. No feed.
May 3, p. m. 4.8 oz. (136.08 gm.) Epsom salts per pig in ½ regular feed.
a. m. 10 grains (648 mgm.) santonin per pig in ½ regular feed.
May 4, a. m. 4.8 oz. (136.08 gm.) Epsom salts per pig in ½ regular feed.

On May 5, 10 worms (both mature and immature) were found in the pen. On May 6, the feeder reported a large number, probably 40 or 50, scattered over the floor of the pen.

Before the treatment several hogs from this experimental lot had been slaughtered, as was the plan of the experiment. Table II shows the number of ascarids found in the small intestine of those killed before the treatment.

TABLE II.—ASCARIDS FOUND IN SMALL INTESTINE OF UNTREATED HOGS

Number	Date	Weight	Ascarids
109	March 29	134	1 male
53	March 29	119	8 females, 7 males
112	March 29	120	7 females
1	April 27	....	7 females, 3 males
2	April 27	..... .	11 females, 11 males
3	April 27	.....	50 females, 75 males

Every hog slaughtered from this lot before treatment was infested with ascarids. Table III shows the number of hogs infested with ascarids after treatment.

TABLE III.—ASCARIDS FOUND IN HOGS AFTER TREATMENT

Number	Date	Ascarids	Number	Date	Weight	Ascarids
119	June 26	0	100	Aug. 3	.....	2 females 1 male
139	Aug. 26	5	76	Sept. 7	.....	0
99	Aug. 26	0	29	Sept. 28	500	1 female 1 male
72	Aug. 3	0	96	Sept. 28	504	0
78	Aug. 3	0	.....	.....	.....	.....

Assuming all the hogs to be infested as Table II would indicate, santonin in this test had an evident anthelmintic effect.

V. **Santonin,** 5 grains per 100 pounds (324 mgm. per 45.4 kgm.) live weight.

Animals—All experimental feeding lots, totalling eighty pigs.

Plan—16 of the pigs were treated individually. The remainder were treated in their respective feeding lots of 4 or 5 pigs each.

March 25, 1918. In ½ regular p. m. feed was given .2 pound (90.7 gm.) Epsom salts per pig.
March 26, a. m. No feed.
p. m. In ½ regular feed was administered 5 grains santonin per 100 pounds live weight.
March 27 In ½ regular feed a. m. .2 pound (90.7 gm.) Epsom salts was given to each pig.

TABLE IV.—WORMS COLLECTED

Lot No.	Number of pigs	15 hours after dose of salts	15 hours after santonin	24 hours after santonin	36 hours after santonin	48 hours after santonin	60 hours after santonin	Total
Comparison of supplements for self-feeding								
1	4	1†	1‡	4† 3‡	5† 5‡	0	0	19
2	4	0	0	0	0	0	0	0
3	4	0	0	0	0	0	0	0
4	5	0	0	0	0	0	0	0
5	5	0	0	6† 3‡ 1*	1† 1‡	0	0	12
6	4	0	0	0	0	0	1‡	1
7	5	0	0	0	0	0	0	0
8	4	0	0	0	0	0	0	0
9	5	0	0	0	1† 1*	0	2‡	4
Light vs. heavy feeding								
1	5	0	0	0	0	0	1†	1
2	4	0	0	0	0	0	1† 1‡	2
3	5	0	1	1†	2† 1‡ 1*	0	0	5
4	5	0	0	0	0	0	0	0
5	5	0	0	0	5†	0	5† 2‡	12
Individually fed								
	16	0	0	0	0	0	0	0
Total	80	1	1	18	23	0	13	56

*Destroyed. †Male. ‡Female.

A total of 56 worms were passed as a result of the santonin treatment. It will be noted that about 32 percent of the worms were passed within 24 hours, or first day after treatment; about 41 percent within 36 hours, second day after treatment; about 23 percent within 60 hours, or third day after treatment. Post-mortem examinations were possible upon only a few of the animals.

It will be noticed that no ascarids were found in any one of the four animals of Lot 2, which accounts for the fact that no worms were found in their pen after treatment. On the other hand one pig from Lot 3 and three out of five from the individually fed lot were infested with ascarids. In those lots, in which worms were found after treatment, No. 5 had one animal infested out of two

Note: Some of the pigs in the individual feeding experiments weighed as little as 40 pounds (18 kgm.). All pigs in this lot weighing under 100 pounds (45.4 kgm.) were given 5 grains (324 mgm.) of santonin.

TABLE V.—POST-MORTEM FINDINGS

Lot No.	Date	No. of pig	Ascarids
Comparison of supplements for self-feeding			
1	May 17	13	0
		82	0
2	April 30	64	0
		20	0
	May 2	2	0
	May 17	98	0
3	May 17	4	Yes
5	April 24	106	11
	May 17	71	0
6	May 17	80	0
9	April 30	27	0
	May 17	57	0
Light vs. heavy feeding			
1	May 17	28	0
		110	Yes
3	May 17	29	0
		16	Yes
5	May 10	63	0
Individually fed lot			
	April 9	73	2† 2‡
		111	0
	May 5	59	5† 5‡
	May 31	45	1†
		69	0

†Male. ‡Female.

examined; Nos. 1 and 3 (heavy vs. light feeding) each had one animal infested out of two examined. Thus santonin was only partially effective in this test.

REPEATED DOSE OF SANTONIN

VI. Twelve lots of 1912 spring pigs on a feeding test were treated for worms. The average weights of the pigs in each lot ranged from 27 to 63 pounds (12.25 to 28.57 kgm.). The method of treatment of each lot was as follows:

June 24, p. m. A light feed.
June 25, a. m. No feed.
p. m. 4 to 5 grains santonin per pig in ½ regular feed.
June 26, a. m. Regular feed.
p. m. No feed.
June 27, a. m. 5 grains santonin per pig in ½ regular feed.
p. m. 1 teaspoonful salts per pig in regular feed.

Results:

Lot 1	5 pigs	1	ascarid	in	pen	48	hours	after treatment
Lot 2	6 "	8	"	"	"	60	"	" "
Lot 3	6 "	3	"	"	"	48	"	" "
Lot 4	5 "	1	"	"	"	48	"	" "
Lot 5	3 "	1	"	"	"	48	"	" "
Lot 6	8 "	1	"	"	"	36	"	" "
Lot 7	4 "	1	"	"	"	48	"	" "
Lot 8	6 "	1	"	"	"	12	"	" "
Lot 9	5 "	0						
Lot 10	9 "	1	"	"	"	36	"	" "
		1	"	"	"	48	"	" "
		6	"	"	"	60	"	" "
Lot 11	4 "	0						
Lot 12	7 "	1	"	"	"	24	"	" "
Total	68 pigs	26	ascarid	in	pen		hours	after treatment

The post-mortem findings on the hogs from these lots are shown in Table VI.

TABLE VI.—POST-MORTEM FINDINGS ON HOGS RECEIVING REPEATED DOSE OF SANTONIN

Pig No.	Post-mortem date	Days after treatment	Findings
11	July 1	4	11 ascarids
3	July 26	30	3 ascarids
88	July 31	34	0 ascarids 5 stomach worms
149	August 1	35	0 ascarids 240 stomach worms
118	August 7	42	12 ascarids 25 stomach worms
147	August 8	43	131 ascarids (mature and immature) 50 stomach worms
173	August 8	43	3 ascarids (immature) 23 stomach worms

Should all the pigs except No. 11 be excluded for the reason they may have become infested after treatment, the eleven ascarids found in the intestine of pig No. 11, posted 4 days after treatment, show that santonin was only partially effective in this test.

SANTONIN AND CALOMEL

Santonin is usually combined with or followed by a purgative. For this purpose calomel is much used. A report of test of santonin and calomel combined follows:

VII. Pig No. 175 received the santonin and calomel treatment as follows:

August 20, 1912, p. m. 1 teaspoonful of Epsom salts in feed.
August 21, a. m. In regular feed { 10 grains (648 mgm.) santonin / 5 grains (324 mgm.) calomel
p. m. Regular feed.
August 22, a. m. Regular feed.
p. m. Dose of Epsom salts.

No worms were found in pen containing the pig. On post-mortem, August 23, about 55 hours after treatment 13 live ascarids were found in small intestine. Santonin and calomel in this test were 0 percent effective.

VIII. Pig No. 15 was given santonin and calomel as follows:

September 29, 1915,	p. m.	No feed.
September 29,	a. m.	.2 pound (90.7 gm.) salts in ½ regular feed.
	p. m.	5 grains (324 mgm.) santonin } in ½ regular feed. 3 grains (195 mgm.) calomel }
September 30,	a. m.	.2 pound (90.7 gm.) salts in ½ regular feed.

Results:

September 30, about 24 hours after treatment, one ascarid was found in pen. October 1 and 2 no worms were found in pen. October 26, on post-mortem examination, 25 ascarids were found in the small intestine. The treatment was therefore less than 4 percent effective.

IX. On March 5, 1916 a lot of five pigs each weighing from 25 to 60 pounds (11.4 to 25.6 kgm.) was given the santonin and calomel treatment as follows:

Fasted for one feed.
Given 1.5 grains santonin and 2 grains (130 mgm.) calomel in ½ regular feed.
Given a dose of Epsom salts in ½ next regular feed.

On March 16, this treatment was repeated—the dosage of santoin and calomel being 3 and 4 grains (135 and 260 mgm.), respectively, in this treatment. On post-slaughter examination of two pigs from this lot, about April 1, one was found to be infested, the other not infested. Santonin and calomel were not effective against ascarids in this test.

SANTONIN, ARECA NUT, CALOMEL, AND SODA

Combinations of santonin, areca nut, calomel, and sodium bicarbonate are frequently recommended for ascarids in pigs. Areca nut alone is often prescribed as a worm remedy, and is presumably combined with santonin to increase the anthelmintic efficacy. It is said that sodium bicarbonate is added to hasten the passage of the remedy thru the stomach.

The following, copied from The Poland China Journal, November 10, 1916, gives the relative proportions of the various drugs usually recommended.

(DOSE FOR 100-lb. PIG)

Santonin .....5 grains (324 mgm.)
Calomel .....2 grains (130 mgm.)
Areca nut .....2 drams (7.8 gm.)
Sodium bicarbonate .....1 dram (3.9 gm.)

(Areca nut—good quality and fresh)

X. Pig No. 86 was placed in a separate pen and treated as follows:

January 2, p. m. .2 lb. (90.7 gm.) Glaubers salts in ½ regular feed.
January 3, a. m. No feed.
p. m. In ½ regular feed { santonin, 8 grains (518 mgm.); calomel, 2 grains (130 mgm.); areca nut, 2 drams (7.8 gm.); sodium bicarbonate, 1 dram (3.9 gm).
January 4, a. m. .2 lb. (90.7 gm.) Glaubers salts in ½ regular feed.

On post-mortem examination, about 24 hours after treatment, 75 worms, most of them mature, all alive and active, were found in the small intestine. The treatment apparently had no effect upon the worms up to 24 hours after it was administered.

REPEATED ANTHELMINTIC TREATMENT

XI. Ten pigs were used in this test. They were kept in a small pasture lot together with ten pigs that received the same feed and care, but no anthelmintic treatment. The lot that received the anthelmintic will be called Lot No. 2. It received the treatment as follows:

P. M. No feed.
A. M. .2 lb. Epsom salts per pig in ½ regular feed.
P. M. { 3 grains (162 mgm.) santonin; 2 grains (130 mgm.) calomel; 2 drams (7.8 gm.) areca nut; 1 dram (3.9 gm.) sodium bicarbonate } per pig in ½ regular feed.
A. M. .2 lb. (90.7 gm.) Epsom salts per pig in ½ regular feed.

Lot No. 2 was thus treated on October 22, 1915, November 6, November 19, and December 3—four treatments in all.

The pigs averaged 98 pounds (44.4 kgm.) at the beginning of test and 144 pounds (65.6 kgm.) at the end of the test.

After the first treatment, 29 ascarids were found in the field. No worms were found after second treatment, and one worm after the third treatment. The pigs were sold to a provision company six days after the fourth treatment. A post-slaughter examination of the intestines showed seven pigs of each lot to be infested with Ascarids. Thus the treatment—santonin, calomel, areca nut, and soda—was but partially effective in this test.

XII. On September 21, 1915, pig No. 28, weighing 60 pounds, was placed in a separate pen and treated as follows:

September 22,	a. m.	No feed.	
	p. m.	.1 pound Epsom salts in ½ regular feed.	
September 23,	a. m.	santonin, 3 grains (162 mgm.) calomel, 2 grains (130 mgm.) areca nut, 2 drams (7.8 gm.) sodium bicarbonate, 1 dram (3.9 gm.)	In ½ regular feed.
	p. m.	.1 pound (45.4 gm.) Epsom salts in ½ regular feed.	

No ascarids were found in pen after treatment. On October 26, a post-slaughter examination revealed three ascarids in the intestine of this pig.

XIII. The treatment—santonin, calomel, areca nut, and soda—was 0 percent effective in this test. The three pigs used in this test were treated as follows:

August 8, 1915,	p. m.	No feed.	
August 9,	a. m.	No feed.	
	p. m.	3 grains (162 mgm.) santonin 2 grains (130 mgm.) calomel 2 drams (7.8 gm.) areca nut 1 dram (3.9 gm.) sodium bicarbonate	per pig mixed with feed.
August 10,	a. m.	3 teaspoonfuls Epsom salts per pig mixed with feed.	

On the evening of August 10, 12 ascarids were found in the pen containing the treated pigs. On August 11, 13 ascarids were found. On August 18, when pig No. 105 from this lot was killed and examined, 64 ascarids were found in the small intestine and 3 whipworms in the colon.

In this test, the treatment—santonin, calomel, areca nut, and soda—was only partially effective.

XIV. Beginning September 23, 1915, five lots of experimental pigs, each weighing from 73 to 100 pounds (33.3 to 45.4 kgm.) were treated as follows:

September 23,	p. m.	No feed.
September 24,	a. m.	.2 pound (90.7 gm.) Epsom salts in ½ regular feed.
	p. m.	medicine in ½ regular feed.
September 25,	a. m.	.2 pound (90.7 gm.) Epsom salts in ½ regular feed.

Dose per pig:
- santonin, 3 grains (162 mgm.)
- calomel, 2 grains (130 mgm.)
- areca nut, 2 drams (7.8 gm.)
- sodium bicarbonate, 1 dram (3.9 gm.)

From 6 to 48 ascarids were found in each pen, the 48 ascarids being found in pen No. 2 containing eight pigs.

The treatment was repeated beginning September 29, p. m. feed. On October 2, 6 ascarids were found in pen No. 2 and 2 in pen No. 4, containing five pigs.

Thus it is apparent that the first treatment was but partially effective. Repeated doses are therefore necessary in order to be effective, and even then all of the worms may not be removed.

XV. Pig No. 69, weighing about 55 pounds was treated as follows:

September 22, 1915,	a. m.	No feed.
	p. m.	.1 pound (45.4 gm.) Epsom salts with feed.
September 23,	a. m.	santonin, 3 grains (162 mgm.), calomel, 2 grains (130 mgm.), sodium bicarbonate, 1 dram (3.9 gm.) } with feed.
	p. m.	.1 pound (45.4 gm.) Epsom salts with feed.

On September 24, 6 adult ascarids were found in the pen containing this pig and on September 25, 1 was found, making a total of 7 ascarids.

On September 27, when pig No. 69 was killed and examined, 6 female and 2 male (adult) ascarids were found in the small intestine and 3 whipworms in the caecum.

The santonin-calomel-soda treatment was 46.6 percent effective against ascarids and 0 percent effective for whipworms in this test.

XVI. A microscopical examination of the feces of pig No. 72 indicated that the pig was not infested with ascarids. However, the pig was treated as follows:

September 22,	a. m.	No feed.
	p. m.	.1 lb. (45.4 gm.) Epsom salts in feed.
September 23,	a. m.	calomel 40 grains (2.6 gm.) in feed.
	p. m.	dose Epsom salts repeated.

No worms were found in pen containing this pig, and on October 26 the pig was killed and examined. No ascarids were found in the intestine, thus confirming the microscopical examination of the feces.

ALOES

Dr. Kenelm Winslow (1901)* states "Aloes is first of all a purgative. It also possesses anthelmintic properties because of its bitter qualities and purgative action". For certain conditions, it is often combined with calomel.

A dose of from 2 to 4 drams (7.8 to 15.6 gm.) is recommended for swine.

*Veterinary Materia Medica and Therapeutics.

XVII. In this test pig No. 14 was placed in a separate pen and treated as follows:

September 28, 1915,	p. m.	No feed.
September 29,	a. m.	.2 pound (90.7 gm.) Epsom salts in feed.
	p. m.	20 grains (1.3 gm.) calomel 2 drams (7.8 gm.) aloes } in feed.
September 30		.2 pound (90.7 gm.) Epsom salts in feed.

No worms were found in the pen containing this pig, and on October 26 a post-slaughter examination of this pig revealed 27 adult ascarids in the small intestine. Calomel and aloes were 0 percent effective in this test.

EPSOM SALTS

XVIII. Pigs No. 28 and No. 75 were not doing well so they were taken out of the experimental lots and given a dose of Epsom salts, .2 pound (90.7 gm.) per pig, in the evening feed. On the following day, 13 ascarids were found in the pen. Several days later, the pigs were killed and 81 ascarids were found in the small intestine of pig No. 28, and 40 in the small intestine of pig No. 75. The Epsom salts in this case was a little more than 10 percent effective against the ascarids.

In no other test did Epsom salts give conclusive evidence of having anthelmintic efficacy.

COPPER SULPHATE

The use of copper sulphate (bluestone) as an anthelmintic against stomach worms in sheep has been tested and recommended by many investigators in this country. At the Ohio Station, hundreds of sheep have been dosed with a solution of copper sulphate with evident success. The strength of solution used was that obtained by dissolving 1 ounce of clear blue crystals in 2 quarts of water.* In view of the evident anthelmintic efficacy of this salt for stomach worms in sheep, it was decided to test it against ascarids in hogs.

XIX. Pig No. 174 was placed in a separate pen August 20, 1912. Beginning with the evening feed, it received 15 grains (972 mgm.) of copper sulphate in each feed for eight feeds. On August 24, a post-slaughter examination revealed 8 ascarids in the small intestine. No worms had been passed by the animal during the test.

*This is a stronger solution than that recommended by the U S Department of Agriculture—1 ounce copper sulphate dissolved in 3 quarts of water. The latter strength of solution is less dangerous to sheep.

The copper sulphate treatment was therefore 0 percent effective in this test.

XX. Pig No. 105 was treated as follows:

July 21, 1915,	3:30 p. m.	1 teaspoonful Epsom salts dissolved in 50 (c. c.) water injected orally, p. m. ½ regular feed.
July 22,	a. m.	No feed.
July 22,	8:00 a. m.	40 c. c. copper sulphate solution, of strength used for sheep stomach worms, administered orally.
	1:00 p. m.	Repeated dose of salts.
July 23	The Epsom salts had little or no effect. Fecal material hard. No worms were passed.	
August 18	Post-slaughter examination showed 64 ascarids in small intestine and 4 whipworms in large intestine and colon.	

Copper sulphate in this test was 0 percent effective against either ascarids or whipworms.

XXI. Pigs No. 88 and No. 20 during the course of Experiment No. 2 were treated individually with copper sulphate as follows:

May 19, 1915,	p. m.	No feed.
May 20,	a. m.	Dose Epsom salts in ½ regular feed.
	p. m.	Solution of 2 grams copper sulphate in regular feed.
May 21,	a. m.	Dose Epsom salts.

No worms were found in pens containing these pigs after this treatment, and fecal examination on May 29 revealed 365 ascarid eggs on first slide from No. 88 and 271 from No. 20.

Pig No. 20 was treated again as follows:

July 21, p. m.	No feed.
July 22, a. m.	Solution of 8 grains (518 mgm.) copper sulphate mixed with ½ regular feed.

The results of the post-slaughter examination of these pigs as reported in Experiment No. 2 were 13 ascarids found in the intestine of pig No. 88 and 34 in the intestine of pig No. 20.

Copper sulphate was therefore 0 percent effective in this test.

XXII. A pen of three pigs, two of which were infested with ascarids, was treated as follows:

August 8, p. m.	No feed
August 9, a. m.	No feed.
August 9, p. m.	Feed mixed with 5 percent solution of copper sulphate. No water was given 10 hours before dosing.
August 10, a. m.	3 teaspoonfuls Epsom salts in feed.

No worms were found in this lot until August 17, when 4 ascarids were found.

Copper sulphate may therefore have been partially effective in this test.

XXIII. Three pigs were used in this test. At 9:45 a. m., July 5, 1917 bluestone or copper sulphate solution of the strength used for stomach worms in sheep was administered orally with a syringe. The respective doses follow:

Pig	Weight, pounds	Anthelmintic
83	224	30 c. c. bluestone
9	44	50 c. c. bluestone
49	29.5	66 c. c. bluestone

Post-mortems were made on these pigs about 4 hours after treatment.

Pig No. 83 Stomach full of feed. Copper sulphate solution still in stomach. Mucus of stomach still intact. No ascarids in intestine.

Pig No. 9 Stomach full of feed. Bluestone had not left stomach; mucus was sloughing; 7 live ascarids in intestine.

Pig No. 49 Stomach full of feed. Bluestone still in stomach; mucus sloughed; no ascarids found in the small intestines.

Analyzing the results of this test, it would appear that the anthelmintic should be given on an empty stomach, so that it may pass rapidly into the small intestine. The test also shows the effect of copper sulphate upon the lining of the alimentary tract. The writer has posted sheep previously treated with copper sulphate, and found the mucus completely sloughed.

COPPERAS

Sulphate of iron (copperas) is frequently mentioned as a remedy for worms. The Iowa State Agricultural College, Extension Department, in Bulletin No. (1908), makes the following statement concerning copperas as a remedy in hogs:

> Sulphate of iron (copperas) is a very good remedy. It should be ground up to a fine powder by the druggist of whom it is purchased. The dose is 1 dram (3.9 grams) per 100-pound hog; 2 drams (7.8 gm.) for a 300-pound hog. Sulphate of iron is dissolved in warm water and mixed with the feed, care being taken that the mixture is as near perfect as it can be. This remedy should be fed every other morning for a week. In bad cases it may be fed every morning for two weeks.

XXIV. On January 18, 1913 two pigs, averaging 60 pounds (27.2 kgm.) each, were started on an experiment to test the value of iron sulphate for removing intestinal worms. The iron sulphate was dissolved in warm water, and each morning's feed for five days was mixed with this solution. Each morning's dose consisted of 1 dram (3.9 gm.) per 100 pounds live weight.

On the afternoon of January 22, a post-mortem examination of pig No. 71, which had received five doses of the iron sulphate, showed 17 very large round worms (ascarids) in the small intestine.

On January 28, a post-mortem examination of pig No. 11, which also had received five doses, revealed 23 very large ascarids in the small intestine.

The iron sulphate as used in this test was therefore 0 percent effective.

COPPERAS AND ARSENIC

Quitman, Veterinary Materia Medica and Therapeutics, says concerning arsenic (arsenous acid), "It assists in the removal of worms."

XXV. Pig No. 35 was treated as follows:

September 28, 1915		No feed.
September 29,	a. m.	.2 pound (90.7 gm.) Epsom salts in feed.
	p. m.	Arsenic 5 grains (324 mgm.) in feed.
		Iron sulphate 20 grains (1.3 gm.) in feed.
September 30,	a. m.	.2 pound (90.7 gm.) Epsom salts in feed.

No worms were found in the pen containing this pig. October 26, a post-slaughter examination revealed one adult ascarid in the small intestine.

The copperas and arsenic treatment was therefore 0 percent effective in this test.

CITRATE OF IRON AND AMMONIA

Iron and ammonium citrate was suggested as a drug that might prove an effective anthelmintic. Three-tenths to six-tenths gram of this material is the usual dose recommended for a dog. In the test of this material against ascarids in hogs 10, 15, and 20 grains (.648, .927, and 1.3 grams), respectively, were used.

XXVI. Two gilts were used in this test. Each was placed in a separate pen and treated as follows:

June 25, 1917,	p. m.	No feed.
June 26,	a. m.	.2 pound (90.7 gm.) Epsom salts in ½ regular feed.
	p. m.	10 grains (648 mgm.) citrate iron and ammonia in ½ regular feed.
June 27,	a. m.	.2 pound (90.7 gm.) Epsom salts in ½ regular feed.

These pigs were under observation every day and no worms were found in their pens. So they were again treated as follows:

July 3, a. m. .2 pound (90.7 gm.) Epsom salts in ½ regular feed.
p. m. { 15 grains (972 mgm.) citrate, iron, and ammonia for pig No. 1.
{ 20 grains (1.3 gm.) for pig No. 2.
(In ½ regular feed.)
July 4, a. m. .2 pound (90.7 gm.) Epsom salts in ½ regular feed.

No worms were found in either of the pens until July 9, six days after the medicine had been administered, when two live ascarids were found in pen No. 1. On July 11, another worm was found in pen No. 1, and on July 13, another, making a total of four. On July 16, a post-slaughter examination revealed ascarids in the intestines of both hogs.

The citrate of iron and ammonia was therefore only partially effective in this test.

TURPENTINE

Turpentine is a drug very commonly recommended for round worms in horses and hogs. For hogs it is usually mixed with feed and administered after a fast. Occasionally it is mixed in a barrel of swill and given in repeated doses. From 4 to 15 fluid drams is the dose recommended for swine.

Turpentine is so commonly recommended and used that perhaps a word of precaution should be given. The kidneys are said to be very prone to irritation during ite elimination. Large or repeated doses may cause dullness, languor and unsteady gait, constant voiding of small amounts of urine, and irritation of the kidneys.

XXVII. Two pigs were used in this test. At 9:45 a. m., July 5, 1917, turpentine and milk were administered orally as follows:

Pig	Weight, pounds	Anthelmintic
104	25	30 c. c. turpentine in milk
53	33	30 c. c. turpentine in milk

The results of post-slaughter examination five hours after dosage, were alike for the two pigs—stomach full of feed; turpentine still in stomach; mucus sloughed; no worms in intestine.

This test would indicate as did Experiment No. 23 (page 20) that the anthelmintic should be administered after a fast. The turpentine also had a tendency to loosen the mucus of the alimentary tract.

XXVIII. Pig No. 21 was placed in a separate pen on February 10, 1915, and treated as follows:

February 10,	p. m.	No feed.
February 11,	a. m.	One-half regular feed with dose of Epsom salts.
	p. m.	15 c. c. turpentine mixed with milk in feed.
February 12,	a. m.	One-half regular feed with Epsom salts.
	p. m.	15 c. c. turpentine in milk mixed with feed.

The pig would not eat the feed containing the salts, so the salts was administered by means of a drenching bottle. Most of the first feed, containing the turpentine, was cleaned up by the pig, but it refused to eat the second feed.

On February 16, a post-mortem examination revealed 15 adult ascarids in the small intestine.

The turpentine in this test was therefore 0 percent effective.

XXIX. Three pigs, averaging about 70 pounds, were used in this test. They were treated as follows:

April 22, 1918,	p. m.	.2 pound (90.7 gm.) Epsom salts in ½ regular feed.
April 23		Fasted.
April 24,	a. m.	9 c. c. turpentine mixed with ½ regular feed.
	p. m.	Regular feed.
April 25,	a. m.	9 c. c. turpentine mixed with ½ regular feed.
	p. m.	Regular feed.

The pigs consumed all feed placed before them.

On April 30, pig No. 14 from this lot was killed and examined. Nine male and five female ascarids were found in its small intestine. No worms were found in the pen, containing the pigs.

Each of the remaining two pigs received 3 c. c. of turpentine mixed with feed on each morning to and including May 9, or 16 doses of turpentine in all for each pig.

They were killed and examined on May 9. Pig No. 27 had 4 female, 1 male, and 1 immature ascarid in its small intestine, and No. 25 had 6 female and 3 male ascarid. No worms were found in the pen containing these pigs.

Turpentine as administered in this test was therefore 0 percent effective.

OIL OF CHENOPODIUM

The Indians, it is said, used infusions of chenopodium as a remedy for worms and from them the early settlers possibly learned of its anthelmintic properties.

Oil of chenopodium is distilled from the seeds or the entire leafy part of *Chenopodium anthelminticum L.*, commonly called "Chenopodium", "American wormseed", or "Jerusalem oak". This plant grows wild in various places of the United States.

The shortage and resulting high price of the classic remedies, thymol and santonin, has induced the medical profession to look for a substitute. Oil of chenopodium has thus recently come into prominence, and has proved an effective substitute.

XXX. A pig, weighing about 50 pounds (22.7 kgm.), was used in this test.

Oil of chenopodium (4 c. c. mixed with 30 c. c. of castor oil) was the anthelmintic tested. This mixture was administered by means of a drenching bottle on the morning of April 29, 1918, after a fast.

On May 1, about 54 hours after the chenopodium was given, the pig was killed and examined. One female ascarid was found in the small intestine. It was alive, but was farther removed from the stomach than the usual location of ascarids. A male ascarid was found in the large intestine. It displayed some movement on being removed; however, as it would probably have been expelled, we may consider oil of chenopodium as administered in this test 50 percent effective.

XXXI. Two pigs, each weighing about 50 pounds (22.7 kgm.), were used in this test, each treated as follows:

March 27, 1918,	p. m.	.1 pound (45.4 gm.) Epsom salts in feed.	
March 28,	a. m.	No feed.	
	p. m.	(pig No. 202)	5 c. c. chenopodium 30 c. c. castor oil, by means of a drenching bottle.
		(pig No. 317)	4 c. c. chenopodium. 30 c. c. castor oil, by means of a drenching bottle.

Pig No. 202 passed one ascarid immedately after dosing. Two were found in the pen containing this pig and one was dropped on the morning of April 1, just before the pig was killed for examination.

No ascarids were found in the small intestine or colon. However, three whipworms were found in the caecum and colon. No other worms save those mentioned were found in the droppings collected on March 29, 30, and April 1, and examined by means of sieves.

In the pen, containing pig No. 317, three ascarids were found in the droppings. A post-slaughter examination of this pig revealed no stomach worms, ascarids, or whipworms.

In this test, oil of chenopodium was therefore 100 percent effective against ascarids and 0 percent effective against whipworms.

XXXII. On the afternoon of April 22, 1918, pig No. 106, weighing 116 pounds (52.6 kgm.) was given 4 c. c. of oil of chenopodium mixed with 30 c. c. of castor oil, by means of a drenching bottle.

On April 24 this pig was killed. This pig, partially paralyzed in its hind quarters before administering the chenopodium, was completely paralyzed after dosage. It had access to no food yet its stomach was full of feed. Stasis had probably taken place. Part of the stomach contents was of a greenish color, and a strong odor of chenopodium was detected; no odor of chenopodium was detected in the small intestine.

There were 2 ascarids in the stomach, 1 entering the bile duct and 8 in the anterior portion of the intestine (duodenum). All the worms were alive. Possibly the 3 former had migrated after death, for the alimentary tract was not examined until 3 hours after the animal was killed.

The chenopodium was therefore 0 percent effective in this test.

XXXIII. As the drenching of pigs is rather difficult and dangerous, it was decided to try mixing the oil of chenopodium with the feed. A pig, weighing about 50 pounds (22.7 kgm.) was selected for the test and treated as follows:

April 4, 1918,	p. m.	.1 pound (45.4 gm.) Epsom salts in ½ regular feed.
April 5,	a. m.	No feed.
	p. m.	5 c. c. oil of chenopodium } mixed with milk 30 c. c. castor oil } and cornmeal

The pig did not clean up this mixture. On each day a little fresh cornmeal was mixed with that containing the oil of chenopodium. On April 9 a post-slaughter examination showed one immature ascarid in the small intestine, and the odor of the chenopodium could be detected in the stomach. As administered in this test, oil of chenopodium was 0 percent effective.

MOLASSES

XXXIV. Molasses is sometimes mentioned as a vermifuge. In the fall of 1914 an opportunity to make an observation upon the efficacy of this material as an anthelmintic presented itself. An experiment was then being conducted in which molasses formed a part of the ration. The test covered a period of 50 days. Four of the hogs receiving molasses were slaughtered locally and a post-slaughter examination was made with the following results:

Pig No.	Ascarids in small intestine
61	1 (immature)
20	2 males, 1 female
85	1 male
66	5 females

Molasses therefore is not an effective anthelmintic.

PUMPKIN SEEDS

XXXV. Farmers are frequently advised to feed pumpkins to their livestock, not only because of their succulence, but because the seeds are supposed to have anthelmintic properties.

Pig No. 27 was selected for testing the efficacy of pumpkin seeds as an anthelmintic. It was treated as follows:

September 29, 1915,	a. m.	.2 pound (90.7 gm.) Epsom salts in feed.
	p. m.	25 teaspoonfuls (81 gm.) of ground pumpkin seeds mixed with feed.
September 30,	a. m.	.2 pound (90.7 gm.) Epsom salts in feed.

No worms were found in pen containing this pig. On October 26, 1915, a post-slaughter examination revealed 3 adult ascarids in the small intestine.

Pumpkin seeds as administered in this test were 0 percent effective.

XXXVI. Three pigs, Nos. 80, 14, and 148 were used. They were prepared for dosage by having been given Epsom salts in three succeeding feeds. In the a. m. feed of July 30, 1915, and in each succeeding feed thereafter, including that of August 4, a. m., each pig received 5 teaspoonfuls (16.2 gm.) of ground pumpkin seed.

No worms were found in pen containing these pigs, during or after treatment. A fecal examination before the test was started revealed 60 ascarid eggs on the first slide of material from pig No. 80; no ascarid eggs on two slides from pig No. 14; and 3 on second slide from pig No. 148.

On October 26, 1915, a post-slaughter examination of pig No. 14 revealed 25 ascarids in its small intestine. Three months before, as was noted, an examination of the feces of No. 14 was negative. This fact would indicate that this pig became infested after that time, or that the ascarids were present, but immature, and not giving off eggs. Pumpkin seeds as used in this test were ineffective.

On August 7, No. 37, previously determined to be infested with ascarids, was prepared for dosage by receiving no feed for 48 hours. Its fast was broken with a feed with which was mixed 15

teaspoonfuls of ground pumpkin seeds. In the next feed the pig was given 3 teaspoonfuls of Epsom salts. No worms were found in pen containing this pig. October 26, 1915, a post-slaughter examination revealed 3 adult ascarids in the small intestine.

Pumpkin seeds as administered in this test were 0 percent effective.

MINERAL MIXTURES

Various combinations of numerous substances are frequently prescribed for pigs to be so placed that the pigs will have free access to the mixture. The following copied from Farmer's Bulletin No. 566 is typical:

Charcoal	1 bushel
Hardwood ashes	1 bushel
Common salt	8 pounds
Air-slacked lime	8 pounds
Sulphur	4 pounds
Pulverized copperas	2 pounds

Mix thoroly. Run thru a grinder and place in a self-feeder.

XXXVIII. A litter of six pigs, farrowed May 17, 1915, was used in this test, which was started on June 26, when the pigs were 40 days old. The mixture was placed in a box so that the pigs had free access to it at all times. The amount of the mixture placed before the pigs at various intervals follows:

June 26,	2.3 kgm;	July 10,	2.7 kgm:	July 25,	2.3 kgm.
Aug. 10,	2.3 kgm:	Aug. 16,	1.6 kgm;	Aug. 25,	2.3 kgm.
Sept. 7,	1.8 kgm;	Sept. 16,	5.4 kgm;	Oct. 13,	5.4 kgm.
				Total	26.1 kgm.

August 9, pig No. 203 died. No worms were found in it.

On October 26, after having had access to the mixture for four months, a post-mortem examination of the five remaining pigs was made with the following results:

Pig No.	Final weight		Age, days	Ascarids
	Pounds	Kilograms		
202	89.0	(40.3)	162	0
208	107.25	(48.6)	162	0
206	89.0	(40.3)	162	25
205	124.0	(56.2)	162	0
212	75.0	(34.02)	162	6
203	.....	.....	84	0

Two of the six pigs were infested with ascarids after having had access to the preventive worm mixture for four months. It appears, therefore, that the mixture was ineffective.

XXXIX. Another combination frequently recommended for hogs, to be administered as was the former mixture, is the following:

Common salt	10	lb.
Glauber's salts	10	lb.
Sal soda	10	lb.
Pulverized copperas	10	lb.
Sulphur	3½	lb.

Mix thoroly; run thru a grinder; and place in a self-feeder.

To test this mixture, two lots of one sow and four pigs each were used; one lot to have access to the mixture, the other lot to be used as a control. Both lots received the same care and feed except that one had access to the so-called "medicated salt".

Lot No. 1, receiving the "mixture", contained sow No. 68 and her litter, Nos. 76, 77, 78, and 79.

Lot No. 2, the control, contained sow No. 124 and her litter, Nos. 36, 37, 38, and 39.

The test started April 28, 1917, and ended September 28, 1917. The pigs consumed during the five months 12.5 pounds (5.7 kgm.) of the mixture. Three of the animals in Lot No. 1 had to be taken out of the test before the end, because of hemorrhoids. Following are the results of the post-mortem examination:

Lot No.	Pig No.	Final weight		Date examined	Ascarids
		Pounds	Kilograms		
1	79	145	(65.8)	September 7	0
	78	188	(85.3)	September 15	0
	77	198	(88.8)	September 28	0
	76	206	(93.4)	September 28	1 female

Lot No.	Pig No.	Final weight		Date examined	Ascarids	Total
		Pounds	Kilograms			
2	36	222.5	100.9	September 28	6 females	6
	37	184.0	83.4	September 28	10 females 7 males	17
	38	198.5	89.0	September 28	8 females 6 males	14
	39	177.5	80.5	September 28	2 females 1 male	3

Only one pig of the lot receiving the worm preventive mixture was infested, and that one with only one worm; while every animal in the control lot was infested. The mixture used in this test appears, therefore, to have had some efficacy as a worm preventive. However, the results of a test of the same mixture started December 11, 1917, and ended May 16, 1918, is not so favorable.

XL. Two lots of pigs, just weaned were used in this test. The pigs were kept under similar conditions before weaning. They were divided equally as far as possible with reference to weight, sex, and condition into lots of six pigs each. Lot 1 was used as the control and Lot 2 had free access to the salt mixture. Nine and nine-tenths pounds (4.5 kgm.) of the mixture was placed before the pigs during the test.

All the pigs except Nos. 101, 112, 129, 94, and 12 were examined at the Canton Provision Company. Nos. 127 and 129 were substitutes for 101 and 112.

Lot No.	Pig No.	Date examined	Condition	Ascarids
1	21	May 17		Yes
	32	May 17		Yes
	97	May 17		0
	40	May 17		0
	101	January 16	Hemorrhoids	0
	112	January 16	Losing weight	35
	129	February 26	Losing weight	0
	127	May 17		0
2	92	May 17		Yes
	53	May 17		0
	3	May 17		0
	123	May 17		Yes
	94	May 9	Weak in hindquarters	0
	12	May 17		5

Three pigs out of each lot were infested with ascarids. The "medicated salt" was therefore not an effective anthelmintic in this test.

SAL VET

Many commercial "medicated salts" have been placed on the market, and widely advertised. For most of these mixtures extravagant claims have been made.

XLI. Sal Vet, 1 teaspoonful in the feed twice daily, was given to a lot of five pigs, weighing from 26 to 45 pounds, for a period of eight weeks. Two pigs from this lot were examined after slaughter with the result that both had intestinal worms. In one of the pigs a few of the worms had invaded the liver.

DISCUSSION OF RESULTS

Since many of the animals treated were being used for experimental purposes other than that of testing anthelmintics, it was often impossible to obtain the percentage of efficiency of the anthelmintic treatment. For example, the animals used in test Number 1 consisted of eight experimental feed lots, of four pigs each, which fact made it impossible to determine the total number

of worms in each animal, and the percentage of efficacy of the drug. However, these tests are included in the following table summarizing the results of the investigation, for the reason that they at least will serve to indicate what drugs offer promise of success. This table shows the drug or drugs tested, the number of animals used in the test, the size of the dose and the percentage of efficacy of the drug as measured by the number of worms removed in proportion to the total number present. Three columns of figures are given for each parasite to enable the reader to see at a glance the results of the dosage. Unless otherwise mentioned, a blank space in any one of these columns indicates that the data were not determined. In order to enable the reader to turn to the experiment as described in detail, a reference to the page describing each particular test is given in the contents.

Inasmuch as the data obtained on many of the drugs is very meager, the writer hestitates to advance any conclusion as to the result of the investigations. However, certain statements may be made with reasonable assurance that they will be borne out by the experimental data reported herewith.

Simple purgatives, such as Epsom and Glauber's salts, calomel, and aloes, have little value as anthelmintics. Ascarids in hogs may sometimes be removed by Epsom salts given as a purgative, but the number removed is too small compared to the total number infesting the animal to justify its use as a worm remedy. In view of the fact that most of the anthelmintic tests were preceded by a dose of Epsom salts, considerable data was gathered upon this subject.

Santonin seldom fails to remove ascarids from hogs, and it is more efficacious in repeated doses. However, it does not appear to be as highly efficacious as is sometimes claimed. In the fifteen tests, in which santonin was used, its efficacy ranged from 0 to 46.6 percent. The combination of santonin, calomel, areca nut, and sodium bicarbonate, likewise proved to be less effective than the claims made for it. Probably the statements regarding the effectiveness of this formula as well as that of santonin alone are based upon the number of worms observed in the pens after dosage, with no attempt to determine whether the treated animals were still infested.

Owing to the lack of sufficient data, it would be inadvisable to place copperas (iron sulphate) in the class of inefficacious anthelmintics. Yet, this drug failed to remove even one worm in the one test in which it was used.

Turpentine is not an effective anthelmintic against ascarids in hogs, and the fact that it may cause serious symptoms of nephritis makes its use inadvisable as a worm remedy for hogs.

Sal Vet in the one test in which it was used did not prove efficacious.

The evidence for the homemade mineral mixtures is conflicting. Certainly the mineral mixtures were not efficacious in two of the tests, while in a third test the data obtained would indicate that the mixture used had some promise as a worm preventive. However, too much emphasis should not be placed upon this one test for factors other than the mineral mixtures may have prevented the pigs of the treated lot from becoming infested with ascarids. The necessity for repeating these tests is apparent.

The most effective remedy was oil of chenopodium. The administration of this drug, when preceded by a fast and administered orally, in conjunction with castor oil, proved 100 percent effective. On the other hand, the drug does not appear to be effective when administered upon a full stomach, nor is its administration in the feed satisfactory or effective. It appears necessary, therefore, in order to get the best results from chenopodium, to administer it to each pig individually, in suitable dosage, preceded by a fast. In treating such an unruly animal, this method involves not only considerable labor but also some danger of strangling the pig. However, the labor and danger of strangling the animal may be considerably reduced thru the use of a dosing syringe and a device for holding the animal's mouth open during the operation. Other measures of reducing the labor, such as separating the animals to be treated, into pens roughly according to weight, will suggest themselves to the operator.

Among the drugs and combinations, which gave evidence of having some anthelmintic efficiency against ascarids in hogs under experimental conditions, the following may be mentioned in order of their efficacy:

1. Oil of chenpodium
2. Santonin
3. Santonin and calomel
4. Santonin, calomel, and sodium bicardonate
5. Santonin, calomel, areca nut, and sodium bicarbonate

SUMMARY OF RESULTS OF DIFFERENT TREATMENTS—Continued

Experiment No.	Drug tested	Number of animals treated	Dose	Ascarids			Stomach worms			Whip worms		
				Total number	Number passed	Percentage of efficacy	Total number	Number passed	Percentage of efficacy	Total number	Number passed	Percentage of efficacy
1	Santonin—dose repeated	32	5 grains per pig		51							
2	Santonin—dose repeated	2	5 grains per pig	47	0	0						
3	Santonin—dose repeated	3	5 grains per pig		22(a)							
4	Santonin—single dose	12	10 grains per pig		60							
5	Santonin—single dose	80	5 grains per 100 lb. live weight		56							
6	Santonin—dose repeated	68	4—5 grains per pig		26		343	0	0			
7	Santonin and calomel—single dose	1	10 grains per pig (santonin)	13	0	0						
8	Santonin and calomel—single dose	1	5 grains per pig (santonin)	26	1	4						
9	Santonin and calomel—repeated	5	1.5 to 4 grains santonin		0	0						
10	Santonin, areca nut, calomel, and soda	1	8 grains santonin	75	0(b)							
11	Santonin, areca nut, calomel, and soda—repeated	10	3 grains santonin		30							
12	Santonin, areca nut, calomel, and soda	1	3 grains santonin	3	0	0						
13	Santonin, areca nut, calomel, and soda	3	3 grains santonin	64(c)	25(d)					3	0	0
14	Santonin, areca nut, calomel, and soda—repeated	40	3 grains santonin		(e)					3	0	0
15	Santonin, calomel, and soda	1	3 grains santonin	15	7	46.6						
16	Calomel	1	40 grains santonin	0	0							
17	Aloes, calomel	1	2 drams	27	0	0						
18	Epsom salts	2	0.2 pound	134	13	10						
19	Copper sulphate—repeated	1	15 grains	8	0	0						
20	Copper sulphate—orally	1	1.5 percent solution	64	0	0				4	4	0

(a) Fecal examination showed each animal to be infested.
(b) Post-slaughter examination 24 hours after dosage.
(c) Number found in one animal of the lot.
(d) Number found in pen containing 3 pigs.
(e) See description of experiment.

SUMMARY OF RESULTS OF DIFFERENT TREATMENTS

Experiment No.	Drug tested	Number of animals treated	Dose	Ascarids			Stomach worms			Whip worms		
				Total number	Number passed	Percentage of efficacy	Total number	Number passed	Percentage of efficacy	Total number	Number passed	Percentage of efficacy
21	Copper sulphate—repeated	2	2 grams and 518 mgm.	47	0	0	.....	.....	.....	.....	.....	.....
22	Copper sulphate	3	5 percent solution	.....	4	.....	.....	.....	.....	.....	.....	.....
23	Copper sulphate—orally	3	1.5 percent solution	7 (f)	.....	.....	.....	.....	.....	.....	.....	.....
24	Copperas (iron sulphate)	2	1 dram per 100 lb. live weight	40	0	0	.....	.....	.....	.....	.....	.....
25	Copperas and arsenic	1	5 grains arsenic, 20 grains copperas	1	0	0	.....	.....	.....	.....	.....	.....
26	Iron and ammonium citrate	2	10 grains to 20 grains	.....	4	.....	.....	.....	.....	.....	.....	.....
28	Turpentine—repeated	1	15 cc.	15	0	0	.....	.....	.....	.....	.....	.....
29	Turpentine—repeated	3	48 cc.	29	0	0	.....	.....	.....	.....	.....	.....
30	Oil of chenopodium	1	4 cc.	2	1	50	.....	.....	.....	.....	.....	.....
31	Oil of chenopodium	2	4 and 5 cc.	7	7	100	.....	.....	.....	3	0	0
32	Oil of chenopodium	1	4 cc.	11	0	0	.....	.....	.....	.....	.....	.....
33	Oil of chenopodium	1	5 cc. in feed	1	0	0	.....	.....	.....	.....	.....	.....
34	Molasses	4	Part of ration	10	0	0	.....	.....	.....	.....	.....	.....
35	Pumpkin seeds	1	25 teaspoonfuls (81 gm.)	3	0	0	.....	.....	.....	.....	.....	.....
36	Pumpkin seed—repeated	3	5 teaspoonfuls (16.2 gm.)	25	0	0	.....	.....	.....	.....	.....	.....
37	Pumpkin seed—repeated	1	15 teaspoonfuls (48.6 gm.)	3	0	0	.....	.....	.....	.....	.....	.....
38	Mineral mixture	6	57.42 pounds consumed	31	0	0	.....	.....	.....	.....	.....	.....
39	Mineral mixture	4	12.54 pounds consumed	1 (g)	.....	.....	.....	.....	.....	.....	.....	.....
40	Mineral mixture	6	9.9 pounds consumed	(h)	.....	.....	.....	.....	.....	.....	.....	.....
41	Sal Vet	5	1 teaspoonful in feed twice daily	.....	0 (i)	.....	.....	.....	.....	.....	.....	.....

(f) Post-slaughter examination 14 hours after dosage.
(g) Only one pig infested.
(h) Three pigs infested at conclusion of experiment.
(i) Ascarids found in two animals on post-slaughter examination.

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